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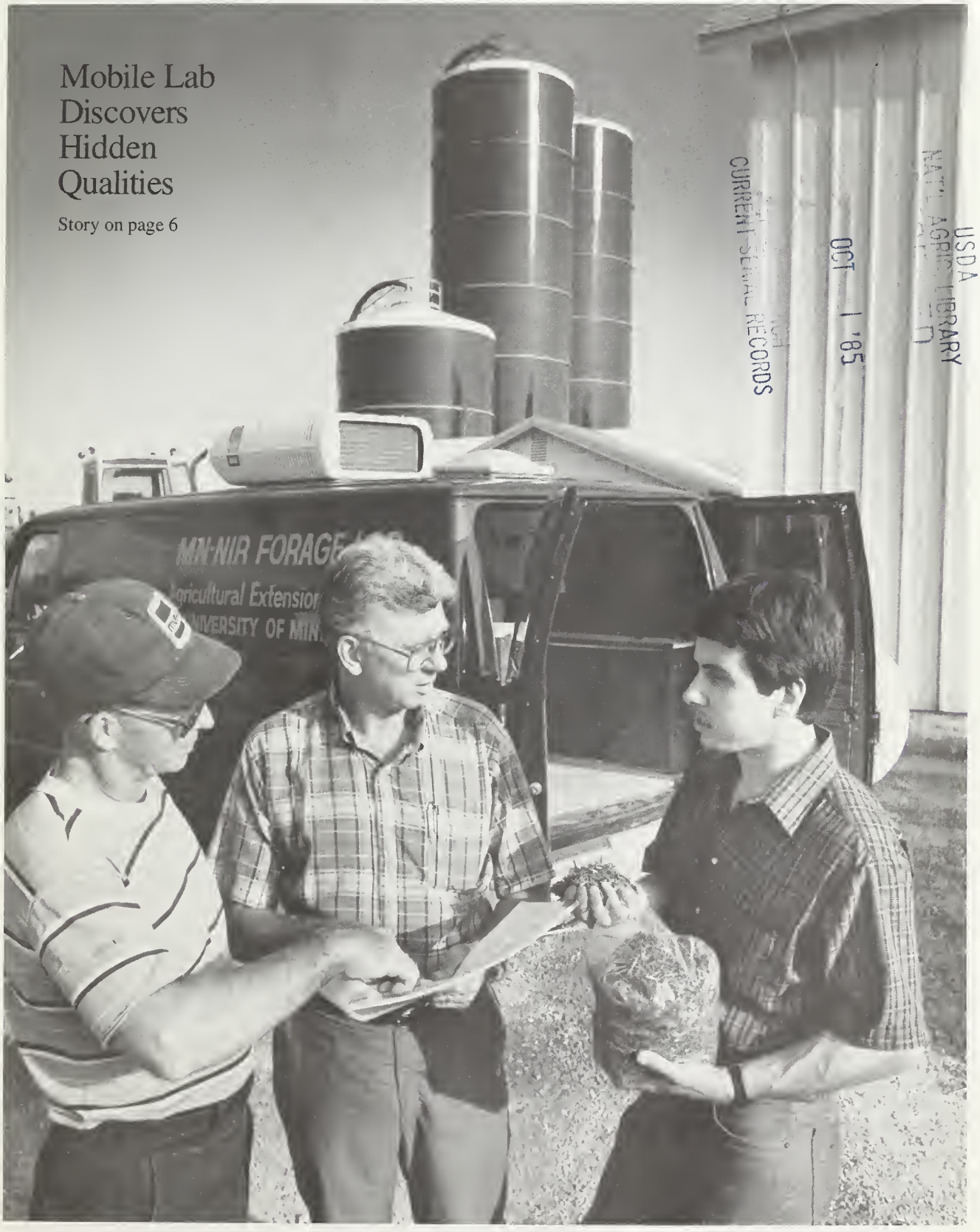
Agricultural Research



Mobile Lab Discovers Hidden Qualities

Story on page 6

Hay Quality Is Mostly Opinion Without Tests

Farmers have been guessing about the feeding value of their forage crops since they first began storing hay for their livestock. Their judgments are often based on the color, odor, and coarseness of the hay, as well as on their stock's enthusiasm in eating it.

The lack of information about forage quality turns buying and selling hay into pure guesswork. In cases where visual examination isn't possible, explaining the color and odor of a barn full of hay over the telephone can be difficult and misleading.

Forages provide more than half of the feed consumed by all livestock in the United States and about two-thirds or more of the nutrients consumed by cattle. Meat and dairy products produced from forage crops represent more than one-fourth of the food ultimately consumed by Americans.

Analyzing the composition of hay—principally protein and fiber content—is the best way to establish its value efficiently so that buyers and sellers can reach an equitable price.

So far, there is no uniform method in use by states or regions for evaluating the more than $1 billion worth of hay marketed annually. And it is a problem that cries for an answer. Take the case of a dairy farmer who must decide on the proper amount of expensive feed concentrates to add to a milking herd's forage to attain a balanced ration. To achieve the most efficient production, it is essential to know the exact amount of nutrients furnished by hay or silage. Too much protein, for example, is simply wasted; too little may lower milk production. An inexpensive, quick, and accurate hay and silage evaluation system could mean lower feed costs and, therefore, lower production costs—perhaps the difference between profit and loss.

One such system discussed in this issue (p. 6) can give almost instantaneous readings (on protein, for example) by computer analyzing near infrared light reflected from a small sample of pulverized hay. Using near infrared reflectance spectroscopy—NIRS for short—provides an accurate alternative to chemical analysis by a laboratory—in a fraction of the time. The system is small enough to be transported in a van to locations where hay is traded or being fed.

The development and extensive evaluation of the NIRS method by Agricultural Research Service scientists working with state experiment station researchers has set the scene for standardizing forage-testing procedures across the country. If the system gains acceptance among buyers and sellers of hay, much of the guesswork will be taken out of the evaluation of forage quality.

Industry groups have believed for some time that chemical analysis and a program of voluntary certification of commercial laboratories is needed to establish industry-endorsed alfalfa hay quality standards. The U.S. Alfalfa Hay Quality Committee (in cooperation with the National Hay Association and the American Forage and Grassland Council) has formulated procedures for laboratory certification based on conventional chemical procedures. The committee has also decided that laboratories may use the NIRS system instead of conventional assays. Certification by either method will ensure that a sample analyzed in one laboratory would produce the same results when analyzed at another laboratory.

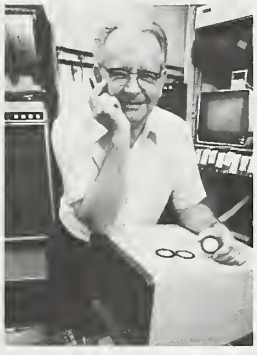
Further, USDA's Federal Grain Inspection Service says that it will review official government standards for all hay in April 1988. Grades are presently based on sensory attributes, such as color, texture, and odor. Officials with the Service say that the standards could be reviewed sooner than 1988, provided rapid and accurate testing methods (such as NIRS) are developed that make objective testing procedures beneficial to the marketing system.

As William C. Templeton, retired ARS agronomist and first coordinator of the NIRS research network, says, "A nationally accepted, uniform system for testing hay quality would take the mystery out of buying and selling hay." Templeton, who is past chairman of the U.S. Alfalfa Hay Quality Committee, predicts that NIRS will become the state-of-the-art method for forage testing and ration balancing in the near future. It not only supports hay marketing and dairy ration planning, but can also prove of immense help in breeding programs and in determining the influence of cutting management, fertilizer practices, moisture stress, and many other variables on forage quality.

Gordon C. Marten
Coordinator, National NIRS Forage Research Project Network.

Agricultural Research

Near infrared reflectance spectroscopy (NIRS)—a technique developed by ARS in cooperation with several universities—enables dairy farmer Ralph Haggstrom (left) to learn his forage's feed value instantly. Extension specialist Richard C. Walter (center), Goodhue County, MN, and Randy L. Ellingboe, Department of Agronomy and Plant Genetics, University of Minnesota, discuss results with Haggstrom, using information printed by computer in a University of Minnesota NIRS van. Story begins on page 6. (0785X753-23A)



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DEPARTMENTS

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Carrot Flavor Affected by Genetics and Storage

Carrot marketers may cash in immediately on some research findings from Agricultural Research Service scientists at Madison, WI. But there's a long-term payoff, too, as plant breeders use the new knowledge to develop better tasting carrots. Improving their flavor could have a positive effect on the $200 million worth of carrots sold in the United States each year.

In studies on carrots in cold storage, those from containers that had been flushed with air daily were judged sweeter by taste panelists after 30 days of storage. During the remaining 3 months of the experiment, sweetness decreased slightly despite air flushes.

Flushing improves the storage environment by preventing buildup of a product of plant respiration called ethylene, says ARS plant geneticist Philipp W. Simon. For reasons not yet fully understood, the perceived sweetness decreases early in storage when ethylene is present even though the ethylene doesn't change sugar concentrations in the carrots.

In another part of the experiment, hybrid carrots bred for mild taste and hybrids with harsher taste were flushed with air plus 100 parts per million ethylene daily for 4 months. The ethylene treatment increased bitterness in both hybrids for the first 2 months of the taste tests. But at the end of the experiment, the bitterness was gone from the naturally milder hybrid.

Undesirable flavors are imparted by chemicals that occur naturally in all carrots in varying amounts. Isocoumarin concentrations that impart a bitter taste can increase dramatically when carrots are attacked by storage pathogens.

Chemical analyses of carrots in the tests indicated that taste panelists often confused a bitter taste imparted by isocoumarin with a harsh taste imparted by terpenoids. Consequently, Simon suggests that carrot breeders wishing to assess variation of the development of bitterness in cold storage should use nonharsh stocks.—**Ben Hardin,** Peoria, IL.

Philipp W. Simon is in USDA-ARS Vegetable and Forage Research, Department of Agronomy/Horticulture, University of Wisconsin, Madison, WI 53706. ■

Chemical Could Preserve Ornamental Crops Longer

Agricultural Research Service scientists are looking for a "fountain of youth" for cut flowers that could save florists thousands of dollars annually.

A new floral preservative called AOAA, for aminooxyacetic acid, is the best compound yet for delaying unsightly aging of flowers, according to horticulturalist Chien Y. Wang and plant physiologist James E. Baker.

By adding AOAA to their standard preservatives, florists can keep cut flowers healthy and attractive even longer. In tests, the compound almost doubled the effect of other preservatives.

AOAA increases a cut flower's lifespan by preventing the production of ethylene, a hormone that begins the ripening and aging processes in flowers, fruits, and vegetables. To produce ethylene, plant enzymes direct a chain of chemical reactions. AOAA inhibits the action of one of the enzymes, thus breaking the chain, Wang says.

It is necessary to treat all flowers in a storage area with AOAA since untreated ones will release ethylene into the air, thus restarting the aging process even in treated ones.

The new floral preservative is actually the second compound that scientists have recently discovered that stops ethylene production. The first was AVG, or aminoethoxyvinylglycine, which works much the same way AOAA does. However, Wang says, "AOAA is twenty times cheaper than AVG," making it more practical.

Baker warns that AOAA may never be approved for commercial use because of its toxicity. He and Wang are now looking at other promising compounds that are not harmful.—**Jessica Morrison,** Beltsville, MD.

James E. Baker is at the USDA-ARS Plant Hormone Laboratory, Bldg. 050, and Chien Yi Wang is at the Horticultural Crops Quality Laboratory, Bldg. 002, BARC-West, Beltsville, MD 20705. ■

Rat Model Exposes Genetic Link Between Dietary Sugar and Diabetes

The 10 to 15 percent of the U.S. population genetically prone to be sugar sensitive would be wise to stick to starchy foods for their source of carbohydrates.

In studies with sugar-sensitive rats, table sugar (a simple carbohydrate) was five times more potent than starch (a complex carbohydrate) in inducing adult-onset diabetes—the most common type of diabetes, says Otho E. Michaelis, a nutritionist at Agricultural Research Service's Beltsville (Maryland) Human Nutrition Research Center.

According to Michaelis, "the findings suggest that sugar may help to promote diabetes in sugar-sensitive people," most of whom are unaware that they have the genetic trait. These people maintain an above-normal blood level of insulin, which goes even higher after a sugar-laden meal.

The test rats were from a special line that reacts to some

In studies at the Beltsville Human Nutrition Research Center in Maryland, animal caretaker Edna Joyner weighs a carbohydrate-sensitive rat. (0785X786-15A)

dietary sugars much the same as people with sugar sensitivity do. "This line of rats provides a unique model for studying adult-onset diabetes," he says.

People with this type of diabetes (also called type II diabetes) produce plenty of insulin—the hormone that ushers blood glucose into the body's tissues where it either serves to fuel the body's activities or is stored for later use. But the tissues are less sensitive to insulin than normal; they have fewer insulin receptors. As a result, glucose builds up in the blood.

By 1 year, more than 80 percent of the rats on the sucrose diet developed diabetes compared with less than 15 percent on the starch diet. And the sucrose diet nearly doubled the already high insulin levels.

Adult-onset diabetes is seen primarily in affluent westernized societies, Michaelis says, prompted by overeating and refined foods. In earlier times when food was scarce, sugar-sensitive people probably benefited from their genetic makeup. Their bodies produced the extra insulin, enabling them to store food more efficiently, he says. "That is no longer the case."—**Judy McBride,** Beltsville, MD.

Otho E. Michaelis IV is at the USDA-ARS Carbohydrate Nutrition Laboratory, Beltsville Human Nutrition Center, BARC-East, Beltsville, MD 20705. ■

Unusual Drought Tolerance in Mexican Cotton Plant

Nonwilting leaves are a key characteristic of cotton plants that will withstand drought, according to Jerry E. Quisenberry in Lubbock, TX.

In a series of studies over several years, Quisenberry, an Agricultural Research Service plant geneticist, used two strains of cotton that had been collected in the 1940's from semiarid regions of Mexico. He expected them to be similarly adapted to dry growing conditions. However, one strain far surpassed the other in tolerating drought. In test after test, this strain had the advantage, as much as 28 percent. Quisenberry believes that its smaller leaves and dense rooting system give the strain its superior water-use efficiency.

This kind of knowledge could help scientists create drought-tolerant cotton varieties for the southern Great Plains where the Ogallala aquifer, which extends from Nebraska to Texas, has provided irrigation water for cotton and other crops for many years. In the past, water was no problem in this semiarid region. "However," says Quisenberry, "with the gradual depletion of the great Ogallala aquifer, and the rising cost of energy to pump the water that remains, we'll see more and more dryland cotton grown. That's why drought-tolerant cotton is essential to farming this region in the future."

Finding drought-tolerant germplasm is generally the first step in creating new plants. "Large genetic variations occur among species," says Quisenberry, "For instance, pineapple can produce as much biomass, or dry matter, as sugarcane but uses only 10 to 12 percent as much water. But variations within a species are usually small. The amount of tolerance we have with this superior cotton strain, T25, pushes the limit of what one has a right to expect."

The extensive rooting system gives it more water-collecting tissue, and the small leaves reduce water loss from the plant when water is available in the soil. This, in turn, makes soil water available longer.

"We must exploit genetic variation to continue growing crops in this region," he says.—**Bennett Carriere,** New Orleans, LA.

Jerry E. Quisenberry is at the USDA-ARS Cropping Systems Research Laboratory, Route 3, Lubbock, TX 79401. ■

Alfalfa Hay Seen in New Light

Karl H. Norris, inventor of near infrared reflectance spectroscopy (NIRS) technology, in his Beltsville laboratory. In 1978, Norris received the prestigious Alexander Von Humboldt award for his work in developing NIRS. (0785X794-17A)

Buyers and sellers of hay and other livestock forage have long been concerned about quality and fair pricing. Now, a new technique—near infrared reflectance spectroscopy (NIRS)—takes the guesswork out of determining forage quality by quickly and accurately measuring protein, fiber, oil, starch, cellulose, and water in forage.

The technique works because "What we are really measuring are vibrations caused by the stretching and bending of hydrogen bonds with carbon, oxygen, and nitrogen," says Agricultural Research Service agronomist Gordon C. Marten, St. Paul, MN.

According to Marten, each of the major organic components of a forage or other feed has light-absorption characteristics (due to hydrogen bonding) in the near infrared region that are specific to that component. "These absorption characteristics cause the reflectance that enables us to identify plant composition."

In practice, the NIRS analyzer, a spectrophotometer connected to a computer, focuses infrared rays on a prepared sample of dried, pulverized plant material. The instrument can then measure and analyze the protein, fiber, and other plant components because each one reflects infrared rays differently.

Next, the NIRS computer mathematically compares the results of the analysis with the results obtained from what is currently the standard approach to analyzing forage: "wet chemistry" tests. The major problem with wet chemistry is that it takes many tedious hours of testing with strong chemical solutions like concentrated sulfuric acid and other caustic compounds.

A technician using wet chemistry tests can analyze 50 samples in about 10 hours. But with the NIRS method, says animal scientist David H. Clark, a technician can analyze four times as many samples in the same amount of time and at one-third the cost.

The final product of the analysis—a computer printout—appears about 2 minutes after the beginning of the test. "We can analyze a prepared sample in about the time it takes to fix a cup of instant coffee," he says.

Clark is with the ARS Dairy Management laboratory located at Utah State University, Logan, UT. This is one of nine laboratories in the National NIRS Forage Research Project Network.

The network was established in 1979 by a group of ARS and state experiment station researchers to study forage quality, ration formulation, hay grading and marketing, and plant breeding materials. Other laboratories in the network are in Beltsville, MD; El Reno, OK; Athens, GA; St. Paul, MN; Albany, CA; East Lansing, MI; University Park, PA; and Alberta, Canada.

NIRS research began in the late 1960's when agricultural engineer Karl H. Norris, now head of the ARS Instrumentation Research Laboratory at Beltsville, MD, designed and built the first NIRS system. He used it to measure the moisture content of grains and oilseeds.

Since then, others have taken the technology to the haymarket and the dairy farm with notable success. John S. Shenk of Pennsylvania State University and his Extension Service colleagues began operating an NIRS computerized system in a

Top left. At the University of Minnesota, St. Paul, alfalfa test plots are harvested to determine comparative feeding quality, yield, and persistence when harvest dates are based on pre-analysis by NIRS versus conventional growth-stage criteria. (0785X747-10A)

Above: National NIRS Forage Research Project Network Coordinator Gordon C. Marten (left) and University of Minnesota graduate student Marvin Hall monitor forage test plots for insect populations that may influence feeding quality. Forage from these plots is periodically assessed by NIRS for feeding value. (0785X746-25)

Alfalfa Hay Seen in New Light

Above: University of Minnesota scientist James L. Halgerson analyzes forage samples for fiber concentrations. These and other conventionally determined chemical values or "knowns" are used to calibrate NIRS equipment. (0785X749-20)

Above right: At the Haggstrom family farm near Cannon Falls, MN, NIRS-van technician Rebecca Nagy Hayes prepares a hay sample for analysis. The self-contained van is equipped with a balance, sample grinder, microwave oven, near infrared spectrophotometer, and computer. (0785X752-29)

Right: Prepared forage sample is inserted into the NIRS van's near infrared spectrophotometer. In approximately 60 seconds, the analysis will appear on the computer screen. (0785X796-9A)

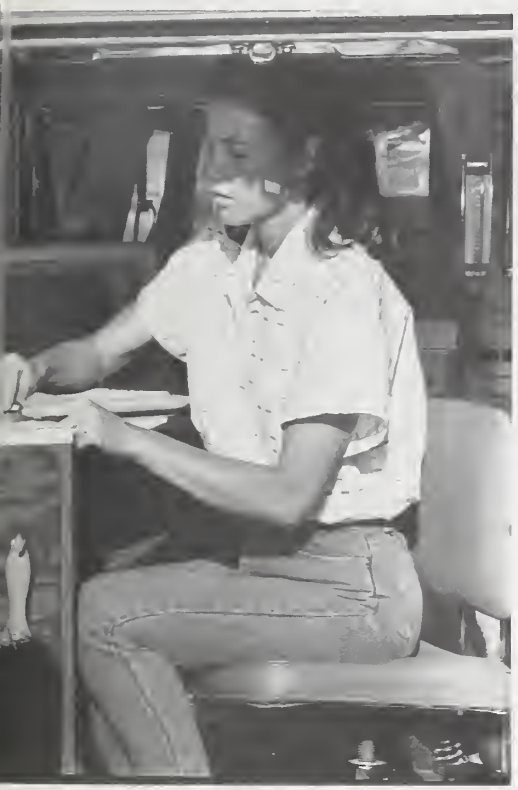
mobile van in 1983. Such systems are now providing farmers in Pennsylvania, Minnesota, Illinois, Wisconsin, and several other states with computer printouts showing the quality of their hay and other forage.

These onsite forage evaluations save farmers the time it takes them to mail samples to a laboratory, have them analyzed, and get the results back—a procedure that could take as long as a month.

"Almost all farmers who use NIRS test results reduce feed costs or improve milk production," says Minnesota Extension dairy specialist James G. Linn. Linn uses these results to help farmers plan livestock feed rations.

Marten, who is also NIRS network coordinator, says Extension Service animal nutritionists are now able to recommend specific forage ration mixtures to dairy farmers within hours of testing samples with NIRS-equipped vans.

Illinois' Department of Agriculture is using an NIRS-equipped van as part of an effort to help farmers improve the nutritional value of their hay, according to Department marketing specialist Larry Aldag. "Growing grass for a hay cash crop," Aldag says, "is also a long-term conservation measure because it is the best way to hold soil in place."



More than 60 million acres of combined hay, corn, and sorghum forage are harvested each year in the United States. "A crop that important should be properly used," says ARS research chemist Franklin E. Barton in Athens. "You cannot achieve a correct nutrient level in a livestock ration if the quality of the forage is unknown.

"After a ration has been fed, it is too late for the farmer to correct an error. A quick, accurate, and early prediction of the feeding quality of forage—such as that provided by NIRS—improves the efficiency and productivity of ration mixtures."—**Ray Pierce,** Peoria, IL, and **Howard Sherman,** Albany, CA.

Gordon C. Marten is in USDA-ARS Plant Science Research at the Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108. ■

Forage-Testing Handbook

A recently released agriculture handbook on "Near Infrared Reflectance Spectroscopy (NIRS)—Analysis of Forage Quality" (AH 643) can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 or the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. ■

F O R A G E T E S T R E P O R T

NIR FORAGE PROJECT
UNIVERSITY OF MINNESOTA
AGRICULTURAL EXTENSION SERVICE

SAMPLE NUMBER	1784
SAMPLE TYPE	HAYLAGE
SAMPLE I.D.	LEG/GRASS,CUT1,5/23/85
DATE PROCESSED	07-10-1985
CLIENT NAME	RALPH & STEVE HAGGSTROM
ADDRESS	RT 2 BOX 219
	CANNON FALLS, MN 55009
	507-778-3377

DETERMINED ANALYSIS	AS SAMPLED	DRY MATTER
MOISTURE, %	38.30	
DRY MATTER, %	61.70	
CRUDE PROTEIN, %	13.09	21.22
% CRUDE PROTEIN IN ADF	.67	1.09
AVAIL. CRUDE PROTEIN, % *	13.09	21.22
ACID DETERGENT FIBER, %	19.94	32.32
NEUTRAL DETERGENT FIBER, %	27.78	45.03
CALCIUM, %	.88	1.43
PHOSPHORUS, %	.18	.29
POTASSIUM, %	1.44	2.34
MAGNESIUM, %	.16	.27
CALCULATED ANALYSIS		
DIGESTIBLE DRY MATTER, %	39.32	63.72
TDN, %	36.52	59.19
NET ENERGY - LACT. MCAL/LB	.383	.621
NET ENERGY - MAIN. MCAL/LB	.360	.583
NET ENERGY - GAIN MCAL/LB	.200	.324
RELATIVE FEED VALUE	123.20	

* CRUDE PROTEIN VALUE TO USE IN RATION BALANCING; CORRECTED FOR HEAT DAMAGE OR UNAVAILABILITY.

Computer printout of forage test performed onsite at the Haggstrom farm. (PN-7184)

Alfalfa Hay Seen in New Light

University of Minnesota professor and forage extension specialist Neal P. Martin reviews forage test results with Goodhue County farmers who participated in a year-long NIRS forage analysis and ration balancing program. Organized by extension specialists, the program provided farmers with NIRS onsite management information for improving and maintaining forage quality throughout the growing season. (0785X755-33A)

The Wider World of NIRS

Near infrared reflectance spectroscopy (NIRS) has many more uses than that of evaluating the nutritive value of hay and other livestock feed.

Since Agricultural Research Service engineer Karl H. Norris first focused near infrared rays on a sample of finely ground wheat in the 1960's, scientists in many fields, as well as industry research and development specialists, have extended the technique to—

- Safely measure human body fat with a hand-held wand. A nearby computer sorts out the data gathered at key spots on the body and displays the percent of total body fat as a digital readout. Full development of this prototype could lead to portable body-fat machines for doctors' offices, physical fitness clubs, and professional sports teams.
- Monitor blood oxygen levels and blood volume in a patient's brain during surgery. Neurosurgeons at Johns Hopkins University in Baltimore, MD, will soon use NIRS to help diagnose brain damage and more accurately administer oxygen and anesthesia.
- Determine hardness in wheats to be used for bread and pastries; also check protein factors in flour that affect the volume of a loaf of bread, the spread of cookies during baking, the texture of cake, and the chewiness of pasta.
- Evaluate beer-brewing quality of barley malt.
- Gauge fat and total solids content in different forms of milk (whole, raw, lowfat, skim), ice milk, ice cream mixes, and fluid chocolate products.
- Quickly analyze prepared hams for salt content.
- Estimate protein, ash, and an amino acid (tyrosine) in freeze-dried and powdered cheese used in dips and salad dressings.
- Detect chemicals in range grasses that cause birth defects in grazing cattle.
- Measure toxic levels of nitrites present in common range plants.
- Screen native range plants for use as alternative sources of gasoline.
- Measure nicotine, tars, alkaloids, phenols, and sterols in tobacco.
- Compare rubber content among guayule plants to determine the most productive varieties.—**Howard Sherman,** Albany, CA.

Karl H. Norris is at the USDA-ARS Instrumentation Research Laboratory, Bldg. 002, BARC-West, Beltsville, MD 20705. ■

Group Size Affects Pigs' Sexuality

In the social life of young female pigs, two may be company but three may not be enough of a crowd to speed them toward puberty and motherhood.

A 2-year study by the Agricultural Research Service in Clay Center, NE, confirmed earlier studies that show that pigs must be raised in groups of more than three if they are to reach puberty on time. The study further indicated that there was no increase in cases of delayed puberty and "silent heat" when the group size approached 30. Some people think pigs shouldn't be raised in groups larger than 10.

The study is part of the Roman L. Hruska U.S. Meat Animal Research Center's research on the effects of total confinement on swine, in response to concerns from the swine industry. The concerns—about problems such as delayed puberty and other sexual development problems—rose in the seventies at the same time as a surge in the construction of total confinement structures, although not all the problems are related to total confinement. Buildings in which growing pigs are housed have pens for groups that range from 10 to 50 or more, with most falling in the 20-to-35 range.

One study compared groups of 3, 9, 17, and 27 and found no significant differences in sexual development among the groups above 3. The pigs in these groups tended to reach puberty earlier and have more regular estrous cycles than those in groups of three.

About 57 percent of those penned in groups of three had regular estrous cycles by the age of 9 months (most pigs reach puberty between the ages of 6 and 9 months) compared with about 80 percent in the larger groups, says ARS animal physiologist Ronald K. Christenson.

The 2-year study of nearly 300 female pigs also showed more cases of irregular estrous activity and silent heat (behavioral anestrous) among females in groups of three. Silent heat is a situation in which the female is capable of conceiving but shows no estrous behavior.

Animal physiologist J. Joe Ford observes swine in studies on the effect of group size on sexual aggressiveness in males. (0785X627-34A)

The pigs included crosses of four breeds—Yorkshire, Landrace, Chester White, and Large White. Christenson found that one crossbreed, Yorkshire × Swedish Landrace, showed more instances of silent heat than another, Chester White × Large White. He says the breed type has a major influence on the sexual development of pigs raised in confinement.

Scientists checked for estrous activity daily by turning a mature boar into each pen for 10 to 20 minutes.

When it comes to proper sexual development, young boars need friends in their pen as much as their female counterparts do.

In another study, Christenson, working with animal physiologist Donald G. Levis of the University of Nebraska's South Central Research and Extension Center, found that young boars (6 to 9 months old) housed in groups of three performed twice as many successful matings as young boars that had been penned individually.

Some time after that study, ARS research physiologist J. Joe Ford began working on the idea that 3.5 to 5.5 months of age is a critical period for development of male behavior. He thinks for example this may be a time when social interaction could provide the cues that stimulate the production of hormones that cause sexual aggressiveness.

If early social interaction is the key to sexual aggressiveness in boars, hog producers will need to be concerned about raising them in groups until they reach the age of 8 to 9 months, after which group housing becomes less desirable because boars may injure one another.

Despite the information coming from total-confinement studies, group environmental effect is something Christenson says he and his colleagues don't completely understand as yet.

Robert R. Oltjen, director of the U.S. Meat Animal Research Center, says the changes in methods of raising livestock have renewed the science of animal behavior. He says that buildings must be adapted to pigs and other livestock, rather than adapting animals to buildings, if farmers want to take full advantage of their genetic potential, including more efficiency in reproduction and lean-meat production.—**Ben Hardin**, Peoria, IL.

Robert R. Oltjen, J. Joe Ford, and Ronald K. Christenson are at the Roman L. Hruska U.S. Meat Animal Research Center, P.O. Box 166, Clay Center, NE 68933. ■

Stopping the Screwworm Pest at the

Above: Screwworm infestation is painfully evident in this brahman steer. Adult flies lay eggs on any wound. The eggs hatch within 12 hours, and the larvae begin feeding on the wound—making it more enticing for other flies. (BN-43414)

Above: Flower nectar is usual food for screwworm flies (about 6 millimeters long), although females occasionally feed on wound juices—most likely prior to laying eggs. (PN-7187)

Right: Tusk-like mandibles protruding from the screwworm larva's mouth rasp living flesh of warmblooded animals, allowing the "worm" to suck juices from blood. Third instar specimen is 1.5 millimeters long. (PN-7186)

The screwworm, once the scourge of the American livestock industry, has been eliminated in this country and much of Mexico, but only constant effort keeps this destructive pest at bay.

The screwworm was eradicated in the United States by the release of billions of radioactively sterilized screwworm flies over a 5-year period, beginning in 1958. The idea of using sterile flies came to E.F. Knipling, an entomologist with the Agricultural Research Service, in the thirties, but it wasn't until 1946 that the research began. Ever since, ARS has played a major role in screwworm eradication that continues to this day, working with the Animal and Plant Health Inspection Service (APHIS), the USDA agency that runs the program.

The program continues because the screwworm is still found in southern Mexico, Central and South America, and some Caribbean islands. With screwworms still present in these places, constant vigilance is necessary by ranchers, farmers, pet owners, and anyone who deals with animals to ensure that reinfestation does not occur in the

Glow Shows Best Flies

An important advance in the screwworm eradication effort has been the recent development of a fluorescent marker, acridine orange, that colors the sperm of the screwworm. The technology will enable scientists to examine with precision the mating behavior of screwworms in the laboratory and possibly in the field. Before, choosing the best strain of laboratory-raised flies was oftentimes a hit-or-miss proposition.

Under ultraviolet light, the marked sperm fluoresces a bright green and persists—in laboratory

Border—and Beyond

southern United States and northern Mexico.

More important, there is a buffer zone of sterile flies across southern Mexico to prevent northern migration of the natural population.

The screwworm fly is bluish green and has three dark stripes on its back. Reddish or orange patches can be seen below the eyes. It is not to be confused with nearly identical blow flies that are not parasitic but rather feed on decaying flesh and garbage.

The screwworm is a parasite of all warm-blooded animals including livestock, pets, and human beings. Its larvae are found only in the flesh of open wounds.

Where screwworms are present, any open wound will become infested. The wound could be a tick bite, the navel opening of a newborn calf, or a snag or scratch from briers or thorns. The open wound attracts the female screwworm fly, and she lays her eggs in masses on the edge of the lesion. When the eggs hatch, the larvae, which have two sharp mouthparts, crawl into the wound and feed on living tissue. After they mature, the larvae drop to the ground, pupate, and shortly emerge as flies to reinfest the old wounds or find new ones. The infested wound becomes more and more attractive to the flies and constantly receives new infestation. An old wound will contain larvae in all stages of development. At this late stage, blow flies may infest the dead tissue of the wound, but their maggots will crawl on the surface while the screwworms will remain attached in clusters to the living flesh.

The stricken animal will retire from the herd and hide in the underbrush. It will make frantic efforts to lick or scratch the wound. And if its infested wounds are not treated, it will die, either by being eaten alive, or by secondary complications. An infestation in an animal's navel will cause death quicker than an infestation in some meatier part, say leg or back.

Screwworm infestations, left unchecked, can kill entire herds of cattle, hogs, sheep, and goats.

The eradication program begun in Florida in 1958 by ARS, state authorities, and livestock producers in the southeastern states relies on insects that are raised in a factory, treated by gamma radiation to make them sterile, and released to mate with the native population. The female mates only once, and when she mates with a sterile male, she lays eggs that do not hatch. Thus the native, fertile population of the flies is overwhelmed, and the pest is eliminated.

By 1959, there were no screwworms in the southeastern United States. In 1962, a more extensive program was started to eliminate the screwworm from the southwestern United States, where the flies caused a $100 million loss annually. A large screwworm rearing laboratory was established by APHIS at Mission, TX, on the Mexican border. By 1963, 99 percent of the flies had been eliminated in the Southwest.

However, for the next several years, the flies continually crossed the border and started new infestations. The buffer zone of sterile flies at the U.S.-Mexican border was simply too extensive to control. Therefore, in 1972, after an agreement was signed with Mexico, which created a Mexico-American Screwworm Commission, a new and larger sterile fly factory was established deeper in southern Mexico, where the Isthmus of Tehuantepec narrows.

The new factory, constructed in 1976 at Tuxtla Gutierrez, is capable of producing up to 600 million sterile flies per week. These sterile flies, along with a screwworm insecticide pellet system called SWASS (Screwworm Adult Suppression System) that attracts and kills screwworm flies, have eliminated screwworms all the way down to the Isthmus of Tehuantepec.

It has been an epic story, covering years and involving federal and state regulatory officials and scientists, producers, and foreign governments. The cost of the entire program is a tiny fraction of the losses caused by the screwworm.

The epic is not over. The screwworm must be contained, and it would be highly desirable to push it even farther south.—**Bennett Carriere,** New Orleans, LA. ■

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tests—for at least 12 days in the mated females.

Richard J. Brenner, an entomologist with the Agricultural Research Service, says, "If the fluorescence is found to be stable in the field, the technique can be used to study the mating interactions of two strains with sterile and native screwworms under *direct* competitive conditions in nature by releasing marked and unmarked sterile strains simultaneously."

Acridine orange does not harm the fly or inhibit mating, is inexpensive, and will enable researchers to select the most effective strain of fly to control this costly and troublesome pest. Studies with acridine orange are already underway in Mexico and at ARS laboratories in Fargo, ND.

And, aside from the immediate and practical usefulness of the marking technique for USDA's screwworm control and eradication program, acridine orange will have broad applicability for entomologists working with other insects.

Brenner himself is finding acridine orange to be useful in his current research on behavior of cockroaches and fleas.—**Bennett Carriere,** New Orleans, LA.

Richard J. Brenner previously worked at Tuxtla Gutierrez, Mexico, and is now at the USDA-ARS Insects Affecting Man and Animals Research Laboratory, P.O. Box 14565, Gainesville, FL 32604. ■

New Process Improves Rice Oil For Food

A new technique now makes it practical—and economical—to get high-quality cooking oil from rice bran.

Cereals research scientists with the Agricultural Research Service, Albany, CA, have been able to prevent the natural oil in bran from deteriorating after milling. Their approach: stabilize the bran by forcing it through a "crop cooker" (also known as an extruder). This machine creates enough frictional heat to destroy powerful enzymes that would otherwise break down the oil.

In studying the oil deterioration problem, the Albany team is the first to come up with a solution that is "economically feasible under a wide range of technical and economic conditions," according to research leader Robin M. Saunders.

Rapid deterioration of oil in rice bran has been of concern to world food experts for at least 25 years. Rice bran contains 15 to 20 percent oil (slightly less than soybeans) and represents "an important potential source of oil in major rice-growing nations, where edible oil is in short supply," says Saunders.

During milling to produce white rice, enzymes that normally cause rice oil to deteriorate are released immediately after the bran (coating surrounding the rice kernel) and germ (embryo) are separated from the kernel. Losses through this natural deterioration could run as high as 10 percent of the oil each day.

To prevent deterioration, oil-processing plants have, until now, been forced to extract the bran oil generally within a day after milling. The short storage life has limited oil production because processors haven't been able to store enough bran for efficient, economical operation.

Another benefit of stabilization—bacteria and other microbiological contaminants are destroyed. "Microbial counts in the stabilized bran are well within safe ranges, and don't increase during storage," Saunders says.

"Although rice bran should be stabilized as soon as possible (within 8 hours) after milling, it can then be stored for 1 to 3 months—even in hot, humid environments—before the oil is extracted."

The U.S. Agency for International Development, which funded the research, has installed a system in the Philippines to demonstrate the stabilization technique.

In the past, rice bran in the United States has been mainly used as a livestock feed. The new process should expand its use as a poultry feed ingredient as well. "Stabilizing kills chick-growth suppressants found in bran," Saunders points out.

Research leader Robin M. Saunders examines stabilized rice bran at the final stage of the extrusion process. The bran can now be stored for up to 3 months before oil is extracted. Mechanic Tom Lievsay (background) checks bran feeder. (0785X807-31)

Although the emphasis of the research has been on producing a clear, odorless, cooking oil, the stabilized bran—both before the oil is taken out and after—may prove to be a "promising source of new foods," Saunders says. One California company, for example, is already making a crunchy rice bran-and-germ product that has many of the same uses as wheat germ.

Saunders describes rice bran as a "major underutilized food resource" and says extracting rice bran

oil alone "could lead to production of as much as 700,000 tons of high-quality oil each year in developing countries."—**Marcia Wood,** Albany, CA.

Robin M. Saunders is at the USDA-ARS Western Regional Research Center, 800 Buchanan St., Albany, CA 94710. ■

Future Holds More Efficient Cotton Ginning

A farmer who produces clean cotton by choosing the right variety, removing weeds, thoroughly defoliating the cotton plant before harvesting, and using other good management practices can still lose up to 20 pounds of cotton per bale to gin machines designed to remove trash.

A program for small computers may help avoid this loss by controlling the number and sequence of ginning machines needed to process a particular batch of cotton. The program considers such factors as current market prices and the amount of foreign matter and moisture in the cotton.

W. Stanley Anthony, acting director of the U.S. Cotton Ginning Laboratory in Stoneville, MS, developed the computer program to control a system that will use sensors to detect the amount of moisture and foreign matter in cotton before—or as—it enters the gin. Anthony says he is still searching for sensors that will work, but this year has brought him the closest he has ever been to success.

He feels that the introduction of small computers to ginning control technology holds great potential. "This work will ultimately lead to continuous measurement of fiber quality during ginning."

Computerization is one symbol of many changes coming as the cotton industry, with the help of the Agricultural Research Service and nongovernment agencies, prepares for the next century.

Anthony sees early success for the research being done by ARS scientists in reducing the amount and kinds of foreign matter in ginned cotton fiber. "Their studies on the selection of cotton types with less hairy leaves will reduce the amount of foreign matter in harvested cotton," he says, and "cleaners on harvesters now being developed will prevent the delivery of cotton containing large quantities of foreign matter."

He notes that some of today's growth-regulating chemicals already appear capable of making cotton plants smaller so they have more cotton and less extraneous plant material.

Genetic selection of cotton for fiber strength will help prevent the breaking of fibers during rigorous ginning and is another goal now within the industry's reach.

Looking at the computerized gin of the future, Anthony foresees the use of energy-consumption and machine-operation monitors to provide very high operating efficiencies. "Gins will be cleaner and quieter with noise at or below safe levels, and airborne dust levels will be reduced to near zero."

With the help of genetics and computers, the cotton gin of 2000 will be better able to meet the world demand for a high-performance natural textile fiber.—**Neal Duncan,** formerly at New Orleans, LA, and **Don Comis,** Beltsville, MD.

W. Stanley Anthony is at the U.S. Cotton Ginning Laboratory, P.O. Box 256, Stoneville, MS 38776. ■

Reader's Opinions Invited

This year *Agricultural Research* has been redesigned. Changes include a new paper that eliminates glare, a new typeface, and changes in layout and content. We invite your comments to help us make further improvements.

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Please send your comments to: Lloyd E. McLaughlin, Editor, *Agricultural Research,* Building 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705.

PATENTS

Dripless, No-Waste Applicator for All Herbicides

A new applicator design applies all types of herbicides, including wettable powders, with virtually no waste and no damage to the crop. A major improvement over current roller applicators, it is inexpensive to produce and economical to use.

The invention consists of a nonabsorbent, textured roller for transferring the chemical to the plant, a low pressure system for delivering liquid to the roller, and a wiper system for spreading the liquid into a thin film on the roller surface and recirculating the excess. Surface tension between the thin liquid film and the textured roller surface controls dripping even on sloping terrain, while the nonabsorbent surface facilitates cleaning and changing from one chemical to another.

Companies that manufacture agricultural equipment should be interested in the applicator, which can be used to apply all types of liquid-based agricultural chemicals.

For technical information, contact E.J. Peters, 216 Waters Hall, University of Missouri, Columbia, MO 65211. *Patent Application Serial No. 651,563, "Nonabsorbent Roller Applicator."* ■

Fungus Kills Nightshade, Not Tomatoes

Agricultural Research Service scientists have isolated a disease organism that—under the right environmental conditions—kills eastern black nightshade *(Solanum ptycanthum)* without harming most crops.

When infecting nightshade, the organism, a strain of the fungus *Collectotrichum coccodes,* produces lesions that spread and eventually kill the plant. Unlike other strains which are known to kill tomato and potato plants, this strain is harmless to these and all other major crops tested, including corn, grain sorghum, rice, soybeans, cotton, eggplant, peppers, and tobacco.

For further technical information, contact Robert N. Andersen, USDA-ARS Plant Science Research, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108. *Patent Application Serial No. 06/738,707, "Control of Eastern Black Nightshade with a Fungal Pathogen."* ■

Crops Absorb Emulsified Oil

A chemical treatment may permit crop residues to be used to remove small amounts of oil emulsified in water.

Straw from wheat, oats, rice, barley and rye, and cornstalks, cobs, and husks are examples of the many plant parts that can be treated with fatty quaternary ammonium salts to improve their ability to remove oil from water.

The reaction with ammonium salt gives plant fibers the proper balance between an affinity for water and an affinity for oil. The need for this balance had not been recognized before, according to the inventor.

The treatment also causes the fibers to swell and separate in water to provide maximum surface area for oil removal.

For further technical information, contact George F. Fanta, USDA-ARS Northern Regional Research Center, 1815 N. University St., Peoria, IL 61604. *Patent Application Serial No. 06/738,815, "Oil-Absorbent Cellulosic Derivatives."* ■

Patents Available for Licensing

A catalog listing all U.S. Department of Agriculture patents is available on request. If you are interested in receiving the catalog or applying for a license on a patent, write to the Coordinator, National Patent Program, USDA-ARS, Rm. 401-B, Building 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. ■